REMARKS

CLAIMS OBJECTIONS

Claim 1 was objected to because the phrase "noise-reduced speech signal" was said to be unclear as to "noise-reduced value" and it was indicated that "noise-reduced speech signal" should have been "noisy speech signal."

Applicants have not amended claim 1 to change "noise-reduced speech signal" to "noisy speech signal." Under claim 1, a noise-reduced value for a portion of a noise-reduced speech signal is produced from a noisy speech signal. Thus, the noise-reduced value represents a portion of a noise-reduced speech signal and not the noisy speech signal. The distinction between the noise-reduced speech signal and the noisy speech signal has been made clearer by amending claim 1 to indicate that the portion of the noise-reduced speech signal has reduced noise relative to the portion of the noisy speech signal.

Claims 2, 3 and 6 were objected to because they make reference to "a noisy speech signal" instead of "the noisy speech signal". With the present amendment, claims 2, 3 and 6 have been amended to change "a noisy speech signal" to "the noisy speech signal".

Claim 8 was objected to for referencing "the scaling factor" instead of "the scaling parameter". With the present amendment, claim 8 has been amended to change "scaling factor" into "scaling parameter".

Claims 14-17 were objected to for referring to "a harmonic component" instead of "the harmonic component". With the present amendment, claims 14-17 have been amended to change "a harmonic component" to "the harmonic component".

Claims 4, 5 and 20-23 were rejected under 35 U.S.C. §112 second paragraph as being indefinite for referring to "the energy". With the present amendment, "the energy" has been changed to "an energy" in claims 4 and 20.

CLAIMS 1-12

Claims 1-3, 6 and 11 were rejected under 35 U.S.C. §102(b) as being unpatentable over Laroche et al. ("HNM: A Simple, Efficient Harmonic and Noise Model for Speech" 1993,

hereinafter Laroche). Claims 4 and 5 were rejected under 35 U.S.C. §103(a) as being unpatentable over Laroche in view of Yumoto et al. ("Harmonics-to-Noise as an Index of the Degree of Hoarseness", 1982, hereinafter Yumoto). Claims 7-10 were rejected under 35 U.S.C. §103(a) as being unpatentable over Laroche in view of Seltzer (CMU Speech Group 1999).

Claim 1 provides a method of identifying an estimate for a noise-reduced value representing a portion of a noise-reduced speech signal. Under the method, a portion of a noisy speech signal is decomposed into a harmonic component and a random component. A scaling parameter is determined for at least the harmonic component. The harmonic component is multiplied by the scaling parameter for the harmonic component to form a scaled harmonic component. The random component is multiplied by a scaling parameter to form a scaled random component. The scaled harmonic component and the scaled random component are summed to form the noise-reduced value representing a portion of a noise-reduced speech signal wherein the portion of the noise-reduced speech signal has reduced noise relative to the portion of the noisy speech signal.

Support for the amendment to claim 1 is found on page 13, lines 1-9.

The invention of claim 1 is not shown in the combination of cited art, because none of the cited art shows or suggests summing a scaled harmonic component with a scaled random component to form a noise-reduced value representing a portion of a noise-reduced speech signal wherein the portion of the noise-reduced speech signal has reduced noise relative to a portion of a noisy speech signal.

In the Office Action, it was asserted that Laroche shows summing a scaled harmonic component with a scaled random component to form a noise-reduced value on page 3, right column, section 4, lines 6-8. Applicants respectfully dispute this assertion.

Laroche describes a method of analyzing a speech signal to separate it into a harmonic component referred to as a deterministic component and a random or stochastic component. The deterministic and stochastic components are then used during speech synthesis by adding the deterministic component to the stochastic component. In Laroche, the stochastic component is said to contain "friction noise", "glottal airflow", "voiced fricatives" and "plosives".

(Laroche, page 1, second column, lines 19-27). Thus, the stochastic portion of the speech signal includes speech in Laroche.

The goal during synthesis in Laroche is to combine the deterministic and stochastic portions of speech to produce high fidelity in the synthesis of the speech signal. (Laroche, page 4, section 5 last paragraph). In other words, the synthesized speech signal, including the noise, should be a faithful reproduction of the input speech signal that was analyzed. This can be seen on page 4, section 5, last paragraph and FIGS. 3 and 4 of Laroche. Laroche indicates that "Informal listing tests have demonstrated the fidelity of the synthesis" and the top graph in FIG. 3, representing the input speech signal is nearly identical to the overall synthetic signal shown as the bottom signal in FIG. 4. Thus, Laroche is not producing a noise-reduced value, but is attempting to faithfully reproduce the noise in the input signal.

In addition, Laroche does not mention reducing noise in the input speech signal to produce a noise-reduced speech signal. Instead, Laroche is simply attempting to decompose a speech signal and then synthesis a new speech signal from the decomposed parts. No attempt is made in Laroche to reduce the noise when performing speech synthesis.

This is substantially different from claim 1 where summing the scaled harmonic component and the scaled random component forms a noise-reduced value for a portion of a noise-reduced speech signal that has reduced noise relative to the portion of the noisy speech signal. Since Laroche does not show or suggest forming a noise-reduced value in this way, it does not show or suggest the invention of claim 1.

Claim 2

Claim 2 depends from claim 1 and includes a further limitation wherein decomposing the noisy speech signal comprises modeling the harmonic component as a sum of harmonic sinusoids. In the Office Action, EQ. 1 of Laroche was cited as showing a harmonic component as a sum of harmonic sinusoids. However, in rejecting claim 1, the Examiner asserted that A_k in EQ. 1 was the scaling parameter. If A_k is the scaling parameter, then the exponent value in EQ. 1 of Laroche must have been interpreted by the Examiner as the harmonic

component of claim 1. However, under such an interpretation, the harmonic component cannot be the sum formed in EQ. 1. Instead, the harmonic component would be a single summand of that sum. Thus, the rejection of claim 2 is inconsistent with the rejection of claim 1 in that different portions of EQ. 1 are being defined as the harmonic component. If the sum shown in EQ. 1 is treated as the harmonic component, then Laroche does not show multiplying that harmonic component by a scaling parameter to form a scaled harmonic component as found in claim 1, since the deterministic part $s_d(t)$ defined in EQ. 1 of Laroche is not scaled after it is computed. Because of this inconsistency, Laroche cannot be said to include the limitations of both claim 1 and claim 2.

Claims 4 and 5

Claim 4 depends from claim 1 and includes a further limitation wherein determining a scaling parameter comprises determining a ratio of an energy of the harmonic component to an energy of the noisy speech signal. Claim 4 was rejected as being obvious from Laroche in view of Yumoto.

In the Office Action, Yumoto was cited as showing a signal-to-noise ratio based on the energy of a harmonic component divided by the energy of a noise component. The rejection indicated that although the signal-to-noise ratio shown in Yumoto is not the same as the ratio of an energy of a harmonic component to an energy of a noisy signal, it would have been obvious to one skilled in the art to substitute the noisy speech signal for the noise in the ratio. Applicants respectfully dispute this assertion.

First, there is no suggestion in Yumoto for making the substitution proposed by the Examiner. Signal-to-noise ratios are substantially different from signal-to-noisy signal ratios. In particular, in a signal-to-noise ratio, a ratio of 1 indicates that the signal and the noise are equally present in the signal and therefore that the signal is considerably obscured by noise. However, in a harmonic component-to-noisy signal ratio, a value of 1 indicates that the signal is almost entirely composed of harmonic components and therefore contains a great deal of harmonic speech information. Further, the range of a signal-to-noise ratio is substantially different from the range for a harmonic component-to-noisy signal ratio, since the harmonic

component can never have an energy value that exceeds the noisy signal energy. Thus, the harmonic-to-noise ratio shown in Yumoto is not equivalent to nor would it be easily substituted for ratio of the energy of the harmonic component to the energy of the noisy signal found in claim 1.

In addition, the combination of Laroche of Yumoto does not show or suggest using the ratio of Yumoto as a scaling parameter for scaling a harmonic component. In the Office Action, the amplitude of a harmonic component was indicated to be the scaling parameter of the harmonic component. However, there is no suggestion in either Laroche or Yumoto for substituting this amplitude with a signal-to-noise ratio as found in Yumoto. As such, those skilled in the art would not be motivated to form the combination of Laroche and Yumoto suggested by the Examiner.

Since neither Laroche nor Yumoto show a harmonic component-to-noisy signal ratio, and since neither reference shows or suggests using the signal-to-noise ratio as a scaling parameter of a harmonic component, the combinations of Laroche and Yumoto does not show or suggest the invention of claim 4 or clam 5, which depends therefrom.

CLAIMS 7-10

Claims 7 includes a further limitation comprising determining a Mel spectrum for a harmonic component from a harmonic component vector of time samples. Claims 7-10 were rejected under 35 U.S.C. §103(a) as being unpatentable over Laroche in view of Seltzer.

In the Office Action, Seltzer was cited as showing the forming of a Mel spectrum for a speech waveform. Although Seltzer shows the formation of a Mel spectrum, it does not show or suggest forming such a Mel spectrum for a harmonic component that has been decomposed from a noisy speech signal. In addition, those skilled in the art would not combine Seltzer with Laroche. In Laroche, a speech synthesis system is produced. In such speech synthesis systems, as noted in section 5 of Laroche, the goal is to synthesis speech with high fidelity relative to an input speech signal. The Mel spectrum, on the other hand, is used for speech recognition because it reduces the portions of the speech signal that are not useful for

speech recognition and emphasizes other portions of the speech signal, which are useful for speech recognition, using the triangular Mel weighting. This weighting would be destructive if applied to the Laroche system since it would interfere with synthesizing a speech signal with high fidelity. Thus, those skilled in the art would not apply a Mel spectrum to Laroche as suggested by the Examiner.

In claim 8, the Mel spectrum for the harmonic component is multiplied by the scaling parameter. In the Office Action, it was asserted that Seltzer discloses the calculation of the Mel spectrum with a scaling factor pre-multiplied for an input speech signal. Applicants are unclear as to where this pre-multiplied value is found in Seltzer. In addition, the Examiner has not indicated how the Mel spectrum of Seltzer would be combined with Laroche to form claim 8. In particular, in rejecting claim 1, the Examiner cited $A_k(t)$ of Laroche as the scaling parameter. However, it is not clear how the harmonic component, consisting of simply the exponent factor in EQ. 1 of Laroche, could be converted into a Mel spectrum or how Laroche could function after such a conversion to the Mel spectrum with the multiplication of $A_k(t)$. Thus, there is no clear way to combine Seltzer with Laroche to form the invention of claim 8.

CLAIMS 13-25

Independent claim 13 provides a computer-readable medium having computer-executable instructions for performing a set of steps. The steps include identifying a harmonic component and a random component in a noisy speech signal. The harmonic component and the random component are combined to produce a noise-reduced value representing a noise-reduced speech signal that has reduced noise compared to the noisy speech signal. The noise-reduced value is used to perform speech recognition.

The invention of claim 13 is not shown or suggested in the cited combination of art. In particular, Laroche does not show or suggest combining a harmonic component and a random component to produce a noise-reduced value representing a noise-reduced speech signal that has reduced noise compared to a noisy speech signal.

As noted above, Laroche does not form a noise-reduced value. Instead, Laroche attempts to faithfully reproduce an input speech signal during speech synthesis. Thus, noise in the input signal is reproduced in the synthesized speech signal. Laroche makes no mention of reducing noise in a speech signal. Similarly, Seltzer and Yumoto do not show or suggest forming a noise-reduced value by combining a harmonic component and a random component. As such, claim 13 and claims 14-25 are patentable over the cited combination of art.

Claims 20-23

Claims 20-23 are additionally patentable over the cited combination. In claim 20, a scaling value is determined for the harmonic component by determining a ratio of an energy of a harmonic component to an energy of the noisy speech signal. As noted above, none of the cited art shows such a ratio and it would not obvious to those skilled in the art to modify the harmonic-to-noise ratio of Yumoto to form a ratio of an energy of a harmonic component to an energy of a noisy speech signal. Further, there is no suggestion in any of the cited art for using the ratio of Yumoto as a scaling value for scaling a harmonic component. As such, claims 20-23 are additionally patentable over the cited art.

CONCLUSION

In light of the above remarks, claims 1-25 are in form for allowance. Reconsideration and allowance of the claims is respectfully requested.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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